

THE MYTH ABOUT BACON AND THE INDUCTIVE METHOD

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THE popular belief that Francis Bacon was the founder of modern science is so flagrantly in contradiction with all the facts of the history of science and so patently belied by the contents of Bacon's "Sylva Sylvarum" or the second book of his "Novum Organum" that it is most instructive to inquire how such an absurd belief ever gained currency among educated people. Unfortunately, however, the history of science previous to the seventeenth century is practically a closed book to those without both a classical and a scientific training. Even professional historians like Professor Robinson in his "Mind in the Making" seem to confirm the conventional fable that there was no science before the seventeenth century. Some indications, therefore, of the actual situation must be set down at the beginning.

(1) No one can well dispute the fact that the great body of modern science rests on foundations already laid before the appearance of the "Novum Organum" in 1620. One needs only to mention the work of men like Copernicus, Kepler, Galileo, Stevinus and Gilbert in physics, or of Vesalius and Harvey in biology—omitting, for simplicity of argument, the great mathematicians from Archimedes to Tartaglio and Cardanus. As all these men had long lines of predecessors as well as fellow-workers, Bacon's repeated claim that there was altogether no well-established science based on experience before he came on the scene would in any other man be characterized as the claim of a crank or charlatan. Ignorance on Bacon's part is too generous an excuse. For he

certainly must have known something of the epoch-making scientific work of Harvey, whom he knew personally. Does this not make it appear that Bacon's exaggerated claims to originality as to scientific method was the courtier's desire to gain prestige in the eyes of King James? Certainly his treatment of Gilbert's unpublished writings which were entrusted to him did not show any disinterested desire for the spread of truth.

(2) But whatever we may think of the fact and the motives for Bacon's ignoring the scientific work of his own and previous time, there is the still more significant fact that he positively opposed the great constructive scientific achievements of his day—the achievements on which subsequent scientific progress has in fact been based.

(a) He opposed, for instance, the Copernican astronomy which had received notable confirmation in his day through the scientific work of Kepler and Galileo. This fact is so glaring that many of Bacon's admirers have resorted to strange arguments to minimize it. They have attempted to do so either by softening the statement of the fact or by trying to find some justification for Bacon's position. Neither of these arguments, however, is in the least tenable.

Despite the beclouding efforts of Whewell and others, Bacon's opposition to the Copernican astronomy was emphatically explicit. In his "De Augmen. Scient.,"¹ he speaks of "the extravagant idea of diurnal motion of the earth, an opinion which we can demonstrate to be

¹ Book III, Ch. 4.

most false." This he repeats in the "Novum Organum."²

Those who try to save the prestige of Bacon by claiming that in his day the evidence for the Copernican astronomy was inadequate, imply that Bacon's sense of evidence was superior to that of Kepler, Galileo and Gilbert. But this can not for a moment be tolerated by any one familiar with the mathematical work of Kepler, with Galileo's demonstration of the phases of Venus and especially with the very flimsy character of the evidence which Bacon himself adduced for the older view. His boasted proof consisted of nothing else but the naïve repetition of the Aristotelian doctrine that "the eternal motion of revolution appears peculiar to the heavenly bodies, rest to this globe."³

(b) Bacon also opposed the growing and fruitful method of explaining physical phenomena as far as possible in terms of mechanics. This method, begun by the ancient Greeks and developed by the Italians in the latter part of the sixteenth century, did not appeal to Bacon, who believed in *species spiritualis* as the explanation of sound and that the "human understanding is perverted by observing the power of mechanical arts."⁴ Despite a few grudgingly approving words, Gilbert's genuinely experimental philosophy is rejected in principle. His experiments with magnets⁵ are called a waste of time, and his fundamental discoveries in electricity and magnetism which have proved basic are characterized as fables.⁶

(3) Not only did Bacon ignore or oppose what was sound in the science of his day, but he himself, despite all his grandiloquent claims, failed to make a single important contribution to science.

² Bk. I., Ch. 46; *cf.* *Glob. Int.*, Ch. 6.

³ "Novum Organum," II, 35; *cf.* II, 36.

⁴ *Ibid.*, I, 66.

⁵ *Ibid.*, I, 70.

⁶ *Ibid.*, II, 48.

The only two claims in this respect that I have ever seen are that Bacon anticipated Newton's discovery of gravitation and that he discovered heat to be a form of motion. Neither of these claims is true.

The first claim is made by Voltaire in the famous essay which did more than anything else to establish Bacon's great European reputation. But the claim that Bacon anticipated Newton's law of gravitation is absurd on the face of it, since the Newtonian theory is based on the Copernican astronomy, which Bacon rejected. Moreover, Voltaire, like other admirers of Bacon, does not seem to have read Bacon with care or noticed his distinct assertion that bodies lose weight below the surface of the earth.⁷ Newton could certainly not have been influenced by such nonsense. Bacon's knowledge that the speed of falling bodies increases as they approach the earth—which Voltaire confuses with the law of gravitation—was an old commonplace in no way discovered by Bacon, whose views went no deeper than the observation that some bodies are heavy, some light, and some neither.⁸

The second claim, that Bacon anticipated the modern doctrine of heat as a form of motion, is likewise untenable. For Bacon rejected the atomic theory ("Novum Organum," II, 8), and his method of induction led him to infer that the motion which produces heat "should take place not in the very minutest particles but rather in those of some tolerable dimensions."⁹

How far Bacon himself was from making any fruitful contributions to science is amply illustrated by the observations and conclusions on almost every page of his "Sylva Sylvanum" and other pretended scientific works. A few examples from the more widely read "Novum Organum" may be cited: Refusing to grant

⁷ *Ibid.*, I, 33.

⁸ *Top. Part Se. Ob.* 3.

⁹ "Novum Organum," II, 20.

that fire can ever separate the elements of a compound, he recommends the study of the spirit in every body, "whether that spirit is copious and exuberant, or meager and scarce, fine or coarse, aeroform or igniform, etc."¹⁰ Or consider the queer jumble of unrelated phenomena in his tables of instances on which an induction as to heat is to be based, containing the following gems: Confined air is particularly warm in winter, and "the irritation of surrounding cold increases heat as may be seen in fires during a sharp frost." All shaggy substances are warm, and so are spirits of wine. Boiling water surpasses in heat some flames, etc. I am not unaware that with due diligence somewhat similar absurdities may be culled from the pages of Gilbert, Kepler, Galileo, Boyle and even later writers in the *Transactions of the Royal Society*. But these men have positive achievement in science to their credit. Bacon has none. Nor could he very well have made any scientific discoveries so long as he believed in explaining things by "spirits" and relying on "axioms" whereby "gold or any metal or stone is generated from the original menstruum."¹¹

(4) Others have urged that while Bacon did not himself make any direct contribution to science, he founded the true method of science, the method of induction. There is, however, not a single authenticated record of any one ever making any important discovery in science by following Bacon's method and its mechanical tables and twenty-seven prerogative instances. It would, indeed, be most amazing if the man who ignored or rejected what was soundest in the science of his day, and put down as fact or conclusion so many absurdities as Bacon did, should become the originator or true expounder of scientific method.

It is true that some scientists, *e.g.*, Boyle and other founders of the Royal

Society, paid great tribute to Bacon. But none of their really scientific contributions was determined by the Baconian method. It was rather the methods which Bacon rejected, the methods of Kepler, Galileo and Gilbert, that they followed in their successful efforts. Also, the idea of a society for the promotion of natural and experimental knowledge was developed by the Italians (*e.g.*, the Lincean Society, of which Galileo was a member) long before Bacon.

We need not ignore the fact that in the first book of the "Novum Organum" and more especially in his doctrine of the idols, Bacon has given us a most vivid, stirring and still applicable account of the perennial difficulties in the scientific study of nature. But his unusually eloquent appeal for the study of facts as opposed to idle speculation was neither new nor in fact very effective in the actual development of science. In the century before Bacon the Spaniard Vives had made the same criticisms, the same exhortations and almost the same grandiose plans. Indeed, we find the same appeal for the direct study of nature continually urged as far back as the twelfth century by the scholastic Adelard of Bath. But it is all rather futile. Science flourishes not on good intentions produced by pious exhortations, but on the suggestion of definite directions of inquiry and definite workable methods, and these Bacon entirely failed to produce.

Bacon's failure is most instructive because it shows the illusory character of the idea of induction which he and Mill after him made popular. According to this view the scientist begins without any regard for previous thought. Resolved not to anticipate nature, he lets the facts record their own tale. All this is purely Utopian. The facts of nature do not stream in on us with all their relevant characteristics duly marked. The number of possible circumstances that can be noted about any object is indefinitely

¹⁰ *Ibid.*, II, 7.

¹¹ *Ibid.*, II, 5.

large. Scientific progress depends upon considering only the circumstances that turn out to be relevant to the point of our inquiry. But what we consider relevant, *e.g.*, in the inquiry as to the cause of cancer, depends upon previous knowledge. Hence scientific discoveries are not made by those who begin with an unbiased mind in the form of a *tubula rasa*, but by those who have derived fruitful ideas from the study of previous science. In the absence of carefully considered methods of observation that depend upon previous knowledge and critical reflection, the observation of nature herself is sterile. Those who think they can start any natural inquiry without "anticipating nature" or making any assumptions at all are just complacently ignorant. In any case, any one who begins, in the Baconian fashion, to observe nature *de novo* is bound to find many "facts" which are not so. Thus Bacon himself observes that cold diminishes after passing a certain altitude,¹² that air is transformed into water,¹³ that clear nights are cooler than cloudy ones,¹⁴ that water in wells is warmer in winter than in summer,¹⁵ and that the moon draws forth heat, induces putrefaction, increases moisture and excites the motions of spirits.¹⁶ Of course many of the absurd observations that crowd the pages of Bacon were made for him by some of his assistants, like the Reverend Rawley, or taken from popular manuals of his day. But they are in any case typical of what untrained observers can and do record. No reader of Bacon can question his genius or the fertility of his mind; but a comparison of his ideas on science with the works of previous scientists upon whom he heaped rhetorical scorn shows the utter irrelevance of Bacon's ideas to the actual progress of

¹² *Ibid.*, II, 27.

¹³ "Sylva Sylvanum," 27.

¹⁴ *Ibid.*, 326.

¹⁵ *Ibid.*, 885.

¹⁶ *Ibid.*, 889.

science. Thus his classification of the types of motion display great ingenuity. But all such concepts as the "motion of liberty," in which bodies "strive with all their power to rebound and resume their former density," lack the direct relevance which we find in the ideas of the sixteenth-century Italian predecessors of Galileo, like Benedetti. Compare similarly Bacon's vague statements about colors as "solitary" instances or white color as a "migratory" instance with the observations of Kepler's "Dioptrics" or even with the observations on the rainbow in Vitello's Optics published in 1270. The utter futility of the untrained amateur in science is borne in on us when we compare Bacon's ideas on the motion of the pulse, or his explanation of sex organs¹⁷ with the contemporary work of Harvey.

No wonder that a real scientist like Harvey was moved to say that Bacon wrote science like a lord chancellor.

How, then, in the light of the foregoing readily verifiable facts, are we to explain the tremendous extent and persistence of the tradition that looks to Bacon as the founder of modern science?

The first point to note is that Bacon is still eminently readable, while the scientific works of Kepler, Galileo, Gilbert and Harvey, not to mention their predecessors, are inaccessible to the general reader. The change from Latin to the vernacular as the language of the learned, together with the rapid growth of new technical methods since the eighteenth century, has made it difficult for scientists themselves to read the works of their predecessors of the sixteenth or previous centuries. But Bacon can be read by everybody. His pithy sayings are sententious and quotable like Cicero's. The general reader is carried away by the splendid rhetoric with which Bacon denounces as useless all previous work in science; and his errors

¹⁷ "Novum Organum," I, 27.

of fact or irrelevance of ideas are either not recognized as such or else covered by the very broad but unhistorical reflection that they were good enough for Bacon's times.

The main source, however, of the Baconian myth is the great romantic appeal which inheres in the fundamental idea of organizing science on a new basis calling for no special aptitude or technical training. Technical science involves an arduous routine which can not be popular with the uninitiated. The multitude (including scientists away from their special domain) will always delight in any plan for a new deal in science—"a discovery which will lead to the discov-

ery of everything else,"¹⁸ or "a synopsis of all the natures that exist in the universe."¹⁹ That which makes utopias spring up perennially is found in Bacon's idea that if his system could be established "the invention of all causes and sciences would be the labor of but a few years."²⁰ Especially in an age that believes in democracy and mechanical progress it is pleasant to be told that science exists for material enrichment and that everything can be achieved by rules leaving little to superior wits.²¹ It requires painful efforts to disabuse ourselves of such pleasant illusion.

¹⁸ *Ibid.*, I, 129.

¹⁹ *Ibid.*, II, 21.

²⁰ *Ibid.*, I, 112.

²¹ *Ibid.*, I, 111 and I, 122.